950 to 2400 MHz IF Amplifier Using the INA-51063 and INA-54063

Application Note 1139

Introduction

IF Amplifiers for DBS applications generally require a high gain amplifier with moderate power output and less than a 5 dB noise figure. This application note describes a suitable amplifier using two integrated circuits. The first stage uses the Hewlett-Packard INA-51063 while the second stage is a Hewlett-Packard INA-54063. The INA-54063 also has an added feature of a positive gain slope which can be used to offset dielectric board losses. A positive gain slope can also be used to offset the customary high end roll-off the low noise amplifier (LNA).

Circuit Design

The INA-51063 and INA-54063 mmics are designed for nominal 50 Ω input and output impedance. The typical LNB has an IF port with a nominal 75 Ω output impedance making it compatible with other set-top downconverter and CATV equipment. The INA-54063 is matched to 75 Ω with an L network consisting of a shunt L, series L matching network. The matching network resembles a transformer that is tapped-up to make the impedance transformation. The lines can be meandered to fit the allotted space. The

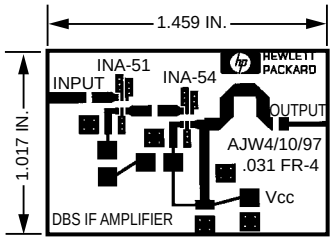


Figure 1. Original Artwork for DBS IF Amplifier for ER = 4.8 and 0.031 inch thickness PCB

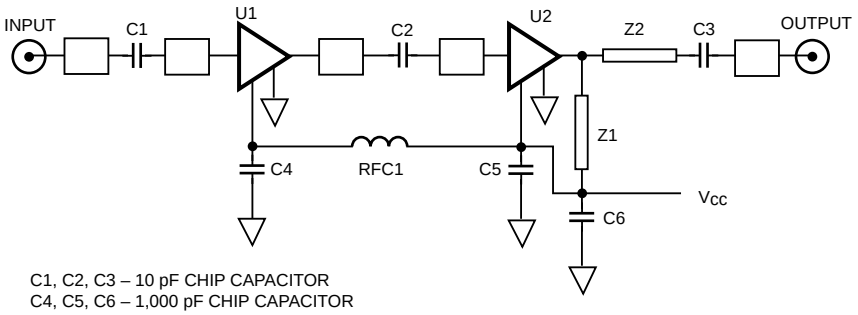
artwork describing this amplifier is shown in Figure 1.

A schematic diagram and parts list are shown in Figure 2. The amplifier is designed to operate from a power supply voltage of 5 volts. Current draw for the INA-51063 is typically 12 mA and 29 mA for the INA-54063. The power supply voltage for the INA-51063 is applied at a terminal separate from the output terminal. The INA-54063 requires power supply voltage at both the supply terminal and the RF output port. The output matching network doubles as a bias network.

A 0.33 µH RF choke is used to provide isolation in the bias circuits between the two stages. Without RFC1, there is potential for feedback in the bias decoupling networks which could result in oscillations.

Device Grounding

The grounding of the devices can greatly effect the performance of the amplifier. The original demo board artwork shown in Figure 1



C1, C2, C3 – 10 pF CHIP CAPACITOR
C4, C5, C6 – 1,000 pF CHIP CAPACITOR
RFC1 – 0.33 µH RFC 9 (COILCRAFT 1008CS-331)
U1 – HEWLETT-PACKARD INA-51063 MMIC
U2 – HEWLETT-PACKARD INA-54063 MMIC
Z1, Z2 – MATCHING NETWORK

Figure 2. Schematic Diagram of IF Amplifier

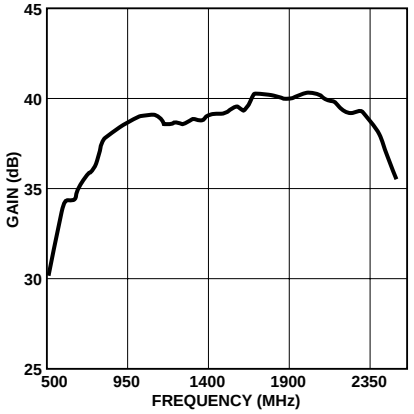


Figure 3. Amplifier Gain vs. Frequency with Original Grounds

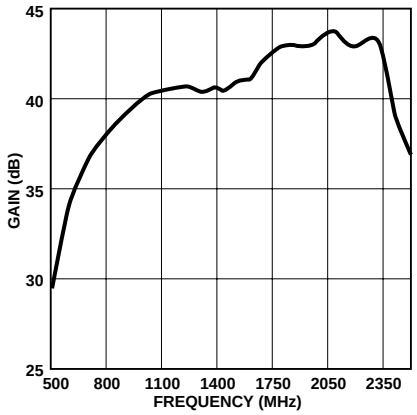


Figure 4. Amplifier Gain vs. Frequency with Modified Grounds

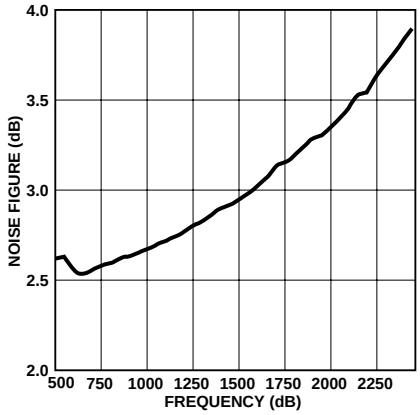


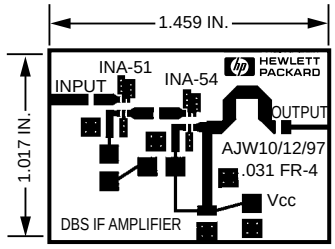
Figure 5. Amplifier Noise Figure vs. Frequency

used separate ground pads for each device ground lead. The swept gain plot with 50 Ω source and load is shown in Figure 3.

The high-end gain seemed to roll-off at a lower frequency than expected. The INA-54063 data sheet suggests the use of separate ground pads as a way of reducing high end gain peaking. Since the two stage amplifier appeared to lack high-end gain, it was decided to fill in the ground pads on the top side of the board. Results were very good. The high end peaked up and the low end was improved slightly. No instabilities were noticed. A swept gain plot with 50 Ω input and output loads is shown in Figure 4.

The revised artwork showing the connected ground pads is shown in Figure 6. Output VSWR with respect to 75 Ω is less than 1.5:1 through 1450 MHz and less than 2.0:1 through 2.3 GHz. Typical P1 dB as measured in a 50 Ω system was measured at +10 dBm at 1.45 GHz and +5 dBm at 950 MHz and +4.5 dBm at 2300 MHz. P1 dB should improve at 950 MHz when measured in a 75 Ω system since that is where the best output match occurs. A plot of noise figure vs. frequency is shown in Figure 5.

(a) 1X Artwork



(b) 2X Artwork

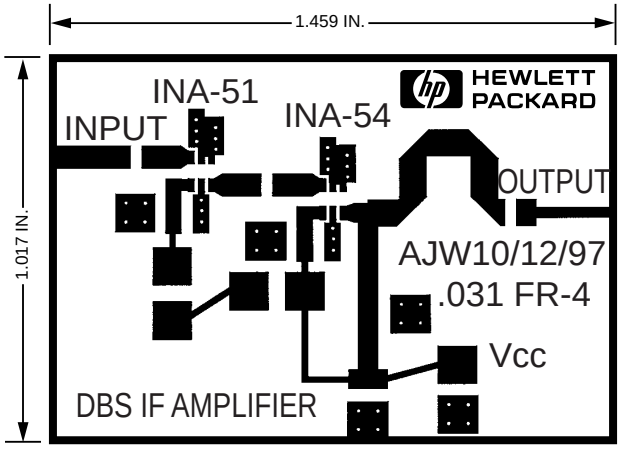


Figure 6. Revised Artwork for DBS IF Amplifier for ER = 4.8 and 0.031 inch thickness PCB

Conclusion

The cascade of the INA-51063 and INA-54063 provides a simple low cost, high gain solution for both DBS and TVRO satellite systems. The low noise figure coupled with good output compression point at 5 volts provides for a high dynamic range IF amplifier.

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